observed from $18^h\ 34^m$ to $19^h\ 06^m$, 75th meridian time ($17^h\ 34^m$ and $18^h\ 06^m$, resp., 90th mer. time). At this station (lat. 32° 43′ N.; long. 97° 15′ W.) the altitude of the sun varied from approximately 23° to 18° 30′.

The angular measurements were secured by the use of the altazimuth, used by the writer in securing measurements of meteor paths. Although homemade, it has been found accurate and it is believed can be relied upon to within 20′ of a true measurement.

The altitude of the sun was measured three times, viz, $18^h\ 36^m\ 10^s$, $18^h\ 43^m\ 05^s$, and $19^h\ 06^m\ 10^s$, 75th meridian time. All other values in Table 1 are interpolated.

The correction necessary at this station to reduce 75th meridian time to local mean solar time is $-1^h\ 29^m$.

The radius of the arc was determined by measuring the altitude of the band at its point of maximum convexity, or on a line drawn from the zenith to the sun's position, the complement of this value being the radius value. It has been assumed throughout that the band maintained a constant width of 2°. The minute values have been given to as close a figure as possible and are believed to be within 5′ of the true measurement.

The horizontal position of the band was obtained by determining the approximate azimuth of either end. These values can not be trusted to within 5° because of the diffused character of the light at these points.

TABLE 1.

Time, 90th meridian.			Altitude of sun.		Solar distance.		The arc's— Radius.		The arc's— Limiting azimuths.
H.	*m.*	*s.*	*Deg.*	*min.*	*Deg.*	*min.*	*Deg.*	*min.*	*Degrees.*
17	36	10	23	00	45	40	21	20	55–85
17	37	10	22	52	45	42	21	26	55–85
17	38	00	22	43	45	42	21	35	58–85
17	39	10	22	34	45	43	21	43	60–86
17	40	20	22	24	45	44	21	52	62–86
17	41	00	22	18	45	44	21	58	65–88
17	42	10	22	09	45	45	22	06	65–88
17	43	05	22	00	45	46	22	14	66–88
17	44	10	21	50	45	46	22	24	68–88
17	45	10	21	42	45	47	22	31	70–88
17	46	00	21	34	45	48	22	38	70–90
17	47	00	21	25	45	49	22	46	74–90
17	48	10	21	16	45	50	22	54	78–90
17	49	20	21	05	45	51	23	05	80–90
17	50	10	20	56	45	51	23	13	82–92
17	55	10	20	12	45	55	23	53	85–92
18	00	00	19	27	46	01	25	31	88–92
18	06	10	18	30	46	09	25	21	90–92

DISCUSSION.

During the time of observation of this arc no evidence in any part of the sky of any other arc, halo, or optical phenomenon was noted. The skies were partly clouded, with about $\frac{6}{10}$Cu. and A.St. Local showers had occurred in various parts of the county prior to the time of the phenomenon, and a thunderstorm had passed south of the station within an hour previous.

Color.—The band of the arc was highly colored, the red nearest the sun, and at one or two of the observations the violet could be distinguished. The red seemed to be intensified at that point nearest the sun, or on an imaginary line from the sun to the zenith. As the observations progressed, the colors faded, leaving the red in prominence until at the last, $19^h\ 06^m\ 10^s$, 75th meridian time ($18^h\ 06^m\ 10^s$ by 90th mer. time), the phenomenon was little short of a red spot directly west of the zenith.

Dark line.—Beginning with the observation at $18^h\ 40^m\ 20^s$, 75th meridian time ($17^h\ 40^m\ 20^s$ by 90th mer. time), and ending with the observation at $18^h\ 44^m\ 10^s$ ($17^h\ 44^m\ 10^s$ by 90th mer. time), a very peculiar phenomenon was observed. The red circumzenithal arc was seen divided horizontally by a single dark line running the full length of the arc, into two bands whose widths were as 2 : 3, the narrower band being next the sun.

An attempt to photograph this phenomenon was unsuccessful, since the lens of the camera was not suited for the work.

The dark line faded rather abruptly and entirely within the minute elapsing between the observations at $17^h\ 44^m\ 10^s$ and $17^h\ 45^m\ 10^s$ (90th mer. time).

This dark line resembled the dark Fraunhofer lines of the spectrum, and this suggested the idea that it partook of the nature of the telluric spectral lines, which are due to absorption by the gases of our atmosphere. Perhaps some other observer has seen this peculiar line and given a better explanation of it.

ATMOSPHERIC ELECTRICAL VARIATIONS AT SUNSET AND SUNRISE.[1]

By E. H. NICHOLS.

[*Reprinted from* Science Abstracts, Sect. A, Aug. 25, 1916, § 916.]

Observations of the positive and negative charge per cubic centimeter, the air-earth current, and the conductivity were made with two Ebert electrometers and a Wilson compensating gold-leaf electroscope. Potential gradients were measured from the charts of the Kelvin water dropper. The two Ebert instruments were used to record the simultaneous values of the positive and negative charges per cubic centimeter. Three consecutive 5-minute readings were taken immediately before sunrise or sunset and three immediately after. Taking the means of the "15 minutes before" and of the "15 minutes after" sunset, it is apparent that a decrease of about 20 per cent occurs in all the quantities (positive charge, negative charge, air-earth current, and conductivity) at the time of sunset. The individual 5-minute readings show that this is not brought about by a sudden change at the instant of sunset, but by a gradual decrease throughout the whole 30 minutes in all the elements. The effect seems to be as strong in the winter months as in the summer. The *sunrise* readings show that the effect is not so pronounced at sunrise as at sunset. A similar investigation was carried out on the potential gradient, making use of two years' records from the water dropper. There is generally an increase in potential gradient both at sunrise and sunset. This is well marked in the winter but negligible in the summer. Again there is no sudden change at the instant of sunrise or sunset, but a gradual one throughout the 30 minutes.

The effect was tried of applying a correction for the diurnal variation of potential gradient at the appropriate time of day, and it was found that after doing this the sunrise and sunset effects were still apparent.—*J. S. Di[nes]*.

IONIZATION OF THE UPPER ATMOSPHERE.[2]

By W. F. G. SWANN.

[*Reprinted from* Science Abstracts, Sect. A, June 26, 1916, § 711.]

From various points of view there are indications that the upper atmosphere is to be treated as a region of high electrical conductivity. One of the first theories which took this hypothesis as one of its bases, was that developed by Schuster to account for the diurnal variation of the earth's magnetism.[3] There are different sources to which the necessary ionization may be ascribed,

[1] Proc., Royal Soc., London, July 1, 1916, 92:401–408.
[2] Terrestrial magnetism, March, 1916, 21:1–8.
[3] *See* Science Abstracts, 1908, § 1158.

but the most natural is that of the ultra-violet light from the sun. In the present paper some calculations are made to determine the possibility of this cause leading to the required effect. Considering first the fraction of the solar energy that is available for gaseous ionization (wave-length less than 135 $\mu\mu$), if the radiation from the sun is treated as black-body radiation, this is deduced to be 1.61×10^{-5} of the total energy entering the atmosphere. It is assumed that the ionization is confined to a layer 300 kilometers thick and the number of ions which will be produced per cubic centimeter per second by this energy is then calculated. Taking suitable values for the coefficient of recombination and the specific velocities of the ions in the high altitudes considered, the specific conductivity σ is next deduced to have a value of 8×10^4 electrostatic units. The value of σ required by Schuster is about 10^3 times as large as this. The above calculation is based on the assumption that the atmospheric pressure in the layer is 1 dyne per square centimeter, and the assumption of a smaller pressure provides a loophole out of the difficulty. A curious result which arises from a further calculation on these lines is that the conductivity of the atmosphere should theoretically tend to an infinite value with increase of altitude, if we assume the laws of variation of the various quantities with pressure—which hold at pressures that are measurable—to apply also with smaller pressures. The physical reason for this lies in the increase in the specific velocity of the ions with diminution of pressure, that is, with increase of altitude.—*J. S. Di[nes]*.

GROUND RAINBOWS.[1]

By A. E. HEATH.

[*Reprinted from* Science Abstracts, Sect. A, May 25, 1916, §526.]

Describes a colored bow similar to a rainbow of about the intensity of a good secondary rainbow, which was seen on the ground of a cricket field at about 11 a. m. on October 14, 1915. The sun was immediately behind the observer, and the bow appeared on the ground, starting from just in front of the observer's feet and stretching on either side in a sweeping curve away from the sun. The bow is explained as being due to sunlight refracted twice at the near surfaces and reflected once at the back surfaces of drops of water that had condensed on gossamer which covered the field. On this theory the angle between the directions of the incident and emergent rays is $42\frac{1}{2}°$ and the bow is the section by the ground, of the cone of which the semivertical angle is $42\frac{1}{2}°$, and the axis is the line joining the observer's eye to the sun. The bow will therefore be a circle, an ellipse, a parabola, or a hyperbola according as the sun is in the zenith, at an elevation of 42° to 90°, of 42°, or of less than 42°, respectively. The elevation of the sun was about 23° at the time of observation, and the bow was proved to be a hyperbola by pegging out its outline on the ground.[2]—*R. C[orless]*.

TEMPERATURE AND RADIATION OF THE SUN.[3]

By F. BISCOE.

[*Reprinted from* Science Abstracts, Sect. A, July 25, 1916, §757.]

The purpose of the first section of the paper is to determine the temperature of the sun from the intensity of radiation for individual wave lengths in its spectrum, using the observations from the Smithsonian Institution at Washington made with the spectrobolometer. The deduced absolute temperature of the solar surface is found to be on the average 7,300° ± 100°C. Other observations made by the author with the aid of color filters in conjunction with the Ångstrom compensation pyrheliometer are also examined for variations of solar radiation over small intervals of time.—*C. P. B[utler]*.

SOLAR CORPUSCULAR RAYS.[4]

By K. BIRKELAND.

[*Reprinted from* Science Abstracts, Sect. A, May 25, 1916, §531.

From the discussion of an extensive series of auroral observations Störmer has decided to regard the aurora as due to positive corpuscles emitted from the sun coming into action in the upper atmosphere of the earth. Birkeland considers that corpuscles are negative and brings forward the evidence given by his extensive experiments on the discharges from a magnetized kathode in a special vacuum chamber.—*C. P. B[utler]*.

AURORA OF SEPTEMBER 30, 1916.

Chesterbrook, Va.—At 8:05 p. m. (75th mer. time), or perhaps one or two minutes earlier, on the evening of Saturday, September 30, a glow was noted low in the north to north-northwest. Careful watching for several seconds made it seem probable that the light was in the form of radiating streamers which diverged slightly, the center being probably 20° to 40° below the horizon. The upper limit at which the streamers could be seen was hard to determine, as the light faded out gradually, but it was probably at least 20° above the horizon. No flickering was noted and no movement of the streamers, as wheeling around the center, was noticed. In all, the aurora was seen for perhaps two minutes; I then reached a neighbor's house where I stayed about 20 minutes. On coming out about 8:28 or 8:30 I looked again for the streamers but saw nothing. This aurora was observed at Chesterbrook, Fairfax County, Va., about 6 miles west or west by north of the heart of Washington, D. C.

One printed mention of this aurora has been noted, viz, in the "New Hampshire," a student's weekly publication at Durham, N. H., the location of the New Hampshire College of Agriculture and Mechanic Arts. In the issue of October 6 or 7 it was stated that a brilliant auroral display had been observed the preceding Saturday night [Sept. 30], the arch being conspicuous.—*Herbert C. Hunter, A. B.*

Alexandria Bay, N. Y.—On Saturday evening, September 30, 1916, a brilliant [auroral] display took place, although of exceedingly brief duration, the leading feature being the rose-red color of the lower fringe of a beautiful drapery which extended from within a few degrees of the northern horizon to about 35° above, the waves of light sweeping upward and in their rapid ascent changing to pale yellow and finally green at the upper limits of the aurora, as if the changing colors were due to the increasing rarity of the atmosphere met with in the passage of the auroral energy.—*Douglas Manning, Cooperative Observer.*

[1] Nature, London, Mar. 2, 1916, 97: 5–6.
[2] See also in this connection *Whitmell, C. T.*, and *Knott, C. G.*, in Nature, London, Mar. 9, 1916, 97: 34.
[3] Warsaw Univ. News, 1915. [In Russian.] Astrophys. Jour., April, 1916, 43: 197–216 extract.
[4] *In* Archives des sciences, 1916, 41: 22–37, 109–124.